Development of the Power Conditioner for PV Systems "SANUPS P73H" with Isolated Operation Function

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1. Introduction

In recent years, anticipation towards renewable energy has risen as a way of achieving both the goals of economic growth and combating global warming. Among these, PV system has a large potentially available supply and is expected to be effective in creating jobs for all industries. As a result, it is expanding through governmental supportive measures and there is great anticipation that diffusion will spread.

Furthermore, the Tohoku Earthquake and the subsequent nuclear disaster raised interest in natural energy, and the Renewable Energy Feed-in Tariff issues in July 2012 turned the tide, leading to a predicted acceleration in the introduction of solar power.

With this background, the market desires high-efficiency and easy-to-use renewable power conditioners for PV systems with high reliability that can be used as emergency power.

This document introduces an overview and features of the newly developed "SANUPS P73H" with isolated operation function.

2. Background of the Development

Sanyo Denki began sales of the 10 kW power conditioner for grid-connected systems "SANUPS P73H" in 2011. This model features high conversion efficiency and a wide DC input voltage range.

However, the power conditioner for grid-connected systems could not be used as power when the utility power grid goes down. .

After the Tohoku Earthquake, the power conditioner for PV systems that could also be used as isolated power sources came to attention. The Ministry of Education, Culture, Sports, Science and Technology requested that if local boards of education install photovoltaic power generation equipment at schools and other public facilities used as disaster prevention shelters during a disaster, in order to preserve power in case of an emergency, the Boards should consider power conditioners with isolated operation function[*1].

To meet this demand, development began to add an isolatedoperation function to the "SANUPS P73H", resulting in the "SANUPS P73H" with isolated operation function.

3. Features

3.1 Isolated operation function

The "SANUPS P73H" with isolated operation function can be switched manually to isolated operation mode, enabling isolated operations. Isolated operation is an operation mode that converts DC power generated by the solar panel into constant frequency, constant voltage, sine wave AC power through voltage regulation and waveform shaping, thus supplying power to the load.

The output electricity format during isolated operations is 3-phase 3-wire 202 V AC with a maximum output of 10 kVA, so if a power outage occurs, it can also be used to supply power to emergency equipment.

The isolated operation function will presumably be used during power outages caused by disasters, so mode switching involved a manual operation, so that the operation mode can be switched after checking the safety of the system.

Fig. 1 shows an image of isolated operations with the "SANUPS P73H" with isolated operation function.

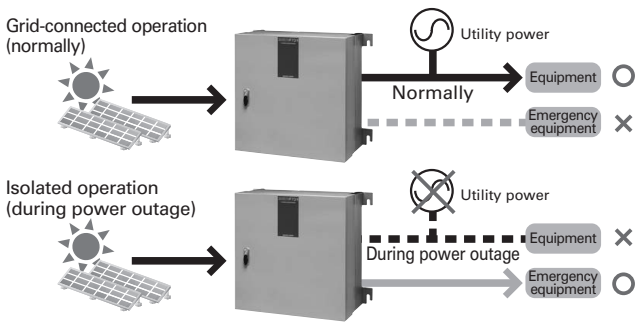


Fig. 1: Image of isolated operation

3.2 High conversion efficiency

The main circuit for the "SANUPS P73H" uses a non-insulation method that does not use an insulation transformer. Furthermore, in order to realize high conversion efficiency, the conversion circuit is composed of a soft-switch type chopper circuit and a 3-level type inverter circuit.

As a result, the "SANUPS P73H" has achieved top class conversion efficiency in the industry[*2] at 94.5%[*3] for both grid-connected operation and isolated operation.

3.3 Wide DC input voltage range

The "SANUPS P73H" has been given a maximum allowance input voltage of 600 V DC so that it can be used as a PV system for high DC voltage used in recent years.

Furthermore, by increasing the input operating voltage range from the conventional model, "SANUPS P73D" , the new model can be combined with diverse types of photovoltaic modules.

Fig. 2 shows the input operating voltage ranges for the "SANUPS P73H" and "SANUPS P73D" .

Since the "SANUPS P73H" covers the input operating voltage range for "SANUPS P73D" , the new model can also be effective as a replacement for the conventional model.

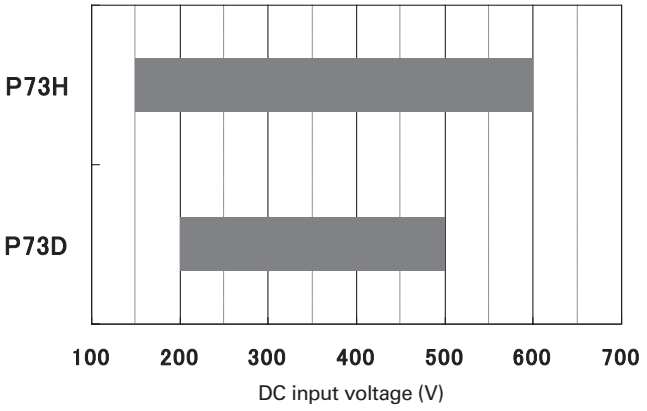


Fig. 2: Comparison of input operating voltage range

3.4 Superior environment resistance characteristics

3.4.1 Dustproof and waterproof performance

The "SANUPS P73H" uses an airtight housing with superior dust proof and splash proof performance. This structure protects the device from ingression of rain, dust, or small bugs to make a highly reliable product that customers can use for long periods of time with great security, even outdoors.

The "SANUPS P73H" achieved protection class IP65[*4] in the external protection performance test from the Product Safety Testing Center Corporation.

3.4.2 Ambient temperature range

The "SANUPS P73H" reworked the circuit parts from the conventional model and expanded the operating ambient temperature to range -25 to 60°C[*5].

With this, restrictions on humidity can be nearly eliminated from the usage environment, making it a product that can be used outdoors securely in every region of Japan.

3.5 Acquisition of JET[*6] authentication

The "SANUPS P73H" with isolated operation function has achieved JET authentication as an outdoor type, wall-mounted 10 kW power conditioner, and therefore customers can reduce the time and cost associated with electric power consultations from the power company.

4. Circuit Architecture

The "SANUPS P73H" is a power conditioner with all of the necessary functions included, so it can be used flexibly with various specifications, regardless of external equipment such as junction boxes and transducers.

4.1. Circuit block diagram

Fig. 3 shows the circuit block diagram for the "SANUPS P73H" .

The "SANUPS P73H" consists of main circuit unit (including a chopper circuit, inverter circuit, and filter circuit) and a control circuit unit (including a control circuit that controls the main circuits, interactive protection circuit, and external communication circuit) .

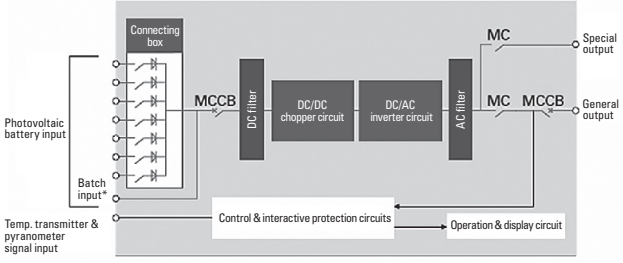
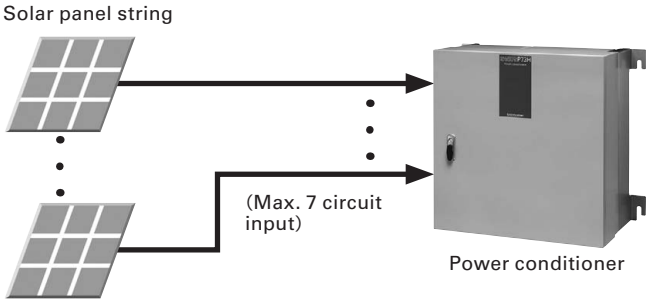


Fig. 3: Circuit block diagram of the "SANUPS P73H" with isolated operation function

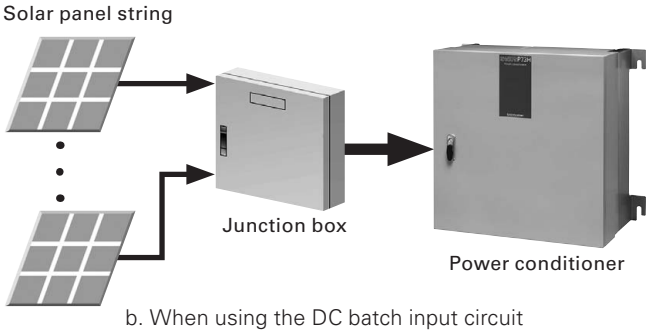
4.2 Flexible DC input circuit

The “SANUPS P73H” has both a junction box circuit (max. 7 circuit input) and a DC batch input circuit as standard specifications, and therefore it can be used for a variety of DC input specifications.

Fig. 4 shows the DC input method for the “SANUPS P73H”



a. When using the junction box circuit



b. When using the DC batch input circuit

Fig. 4: DC input circuits for the “SANUPS P73H”

4.3 Transducer circuit

The “SANUPS P73H” includes a built-in transducer (signal converter) circuit that can connect directly to the pyranometer and temperature transmitter, so an external transducer does not need to be obtained separately.

Furthermore, as with the conventional model, it can be connected to a 4 to 20 mA DC signal from an external transducer.

4.4 External communication circuit

The “SANUPS P73H” uses the same interface (RS-485) and communication protocol for external communications circuits as conventional models, so it can be used in common with the “SANUPS P” series.

As a result, it can communicate with conventional models, which widens freedom for expansion of current systems and output capacity configurations.

5. Options

The “SANUPS P73H” has a wide array of options, making it a power conditioner that can meet the needs of a variety of customers.

5.1 Transformer

The output of the “SANUPS P73H” with isolated operation function is 3-phase 3-wire 202 V AC, but this cannot be used as-is as the power source for common electronic equipment.

Therefore, optional 1.5 kVA, 5 kVA, and 10 kVA transformers are available to produce single-phase 2 wire 100 V AC output. As a result, a power source for information equipment terminals (such as televisions or cellular phones) can be secured even when the utility power grid goes down.

Fig. 5 shows the appearance of the 1.5 kVA transformer. The 1.5 kVA transformer is wall-mounted and the output acts as a 100 V AC outlet that can be connected to DC electrical equipment.

The 5 kVA and 10 kVA transformers are installation models that can be used for 100 V AC and 200 V AC terminal output.

Fig. 5: Appearance of the 1.5 kVA transformer

5.2 SANUPS PV Monitor

The “SANUPS PV Monitor” makes it possible to monitor the status of the PV system from the distance and collect and analyze data from a pyranometer and temperature transmitter.

Fig. 6 shows an image of the connections when using the “SANUPS PV Monitor” for remote monitoring.

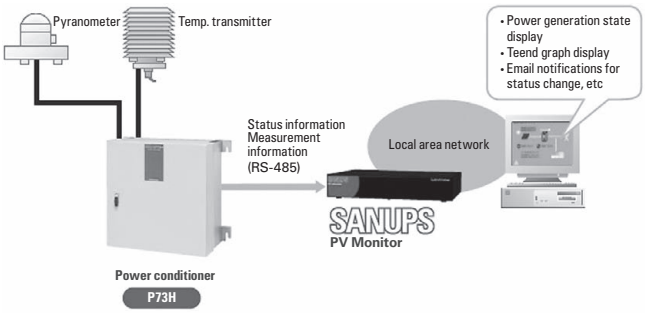


Fig. 6: Image of connection to PV Monitor

5.3 Weather shelter

A weather shelter is optional equipment that provides thermal insulation for power conditioners in direct sunlight. Installing the weather shelter, the power conditioner can be used even in locations exposed to direct sunlight.

The weather shelter is assembled at a site without changing the structure of the "SANUPS P73H" itself. Therefore, it does not affect the "SANUPS P73H" IP65 protective performance.

Fig. 7 shows an image of the installed weather shelter.

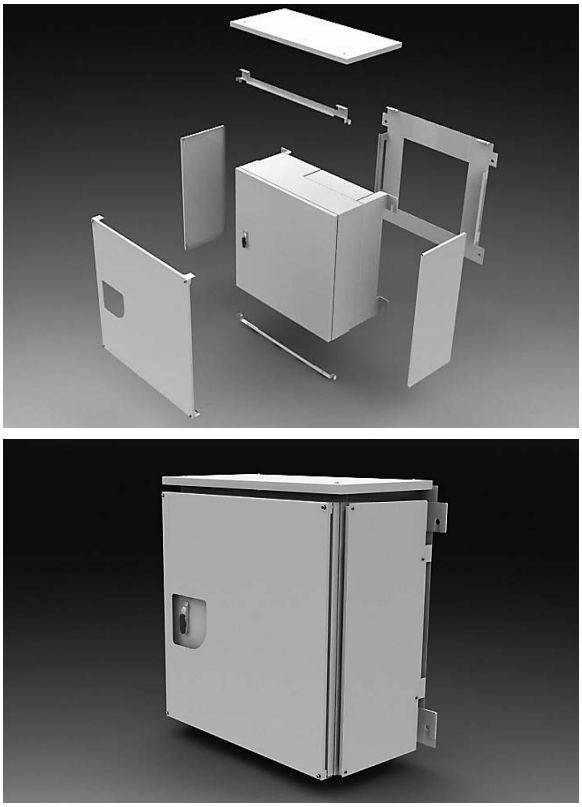


Fig. 7: Image of the installed weather shelter

5.4 Stand-type fixtures

The stand-type fixtures are used when the "SANUPS P73H" cannot be hung on the wall or installed to a solar panel mount, enabling the equipment to be installed outdoors independently.

Fig. 8 shows an image of the stand-type fixtures in use.

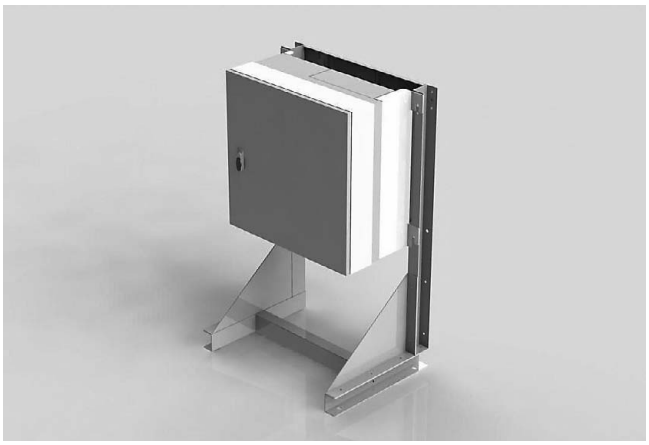


Fig. 8: Stand-type fixtures in use

5.5 Measurement card

The measurement card is optional equipment that is installed in the "SANUPS P73H" and outputs measurement signals for generated power and the amount of generated power. It can provide separate measurements for generated power external to the power conditioner.

Table 1 shows the specifications for the measurement card output signal.

Table 1: Specifications for the measurement card output signal

Item	Output signal	Standard
Generated power	Analog signal	4 to 20 mA DC
Generated power quantity	Pulse signal	100 Wh/pulse or 1 kWh/pulse

6. Specifications

Table 2 shows the specifications for the “SANUPS P73H” , while Fig. 9 shows the appearance.

The newly developed “SANUPS P73H” adds isolated operation function to the existing “SANUPS P73H” for grid-connected systems without changing external dimensions through adding parts and changing the parts layout and control program.

The specifications and performance during grid-connected operation does not change with or without the isolated operation function.

Fig. 9: Appearance of the “SANUPS P73H”

7. Conclusion

This document described the overview of the “SANUPS P73H” with isolated operation function.

Through the development of this model, the JET-approved power conditioner

with isolated operation function is added to the line-up.

With this, the lineup of the “SANUPS P73H” now consists of two models: “P73H103RJ” for grid-connected systems and “P73H103SJ” for isolated operations.

With the expected future growth of PV system, we believe that the demand will increase for power conditioners that have higher efficiency, higher performance, higher reliability, and lower cost.

We will continue to quickly develop products that can handle the requirements from the market, supply products that satisfy customers, and contribute to the realization of the low carbon society.

We sincerely thank the many people involved in the development and realization of this product for their advice and support.

Table 2: Main specifications of the “SANUPS P73H”

Item / Model			P73H103RJ (Grid-connected system type)	P73H103SJ (With isolated function type)	Remarks
Method		Main circuit method	Self-commutation voltage type		
		Switching method	High-frequency PWM method		
		Insulation method	Transformer-less system		
DC input		Rated voltage	400 V DC		
		Maximum allowable input voltage	600 V DC		
		Input operating voltage range	150 to 600 V DC		Rated output range 280 to 550 V DC
		Maximum power point tracking control range	150 to 550 V DC		Only during relay operations
		No. of input circuits	7 circuits (max. 10 A/circuit) 1 circuit (batch input)		In the case of batch input, an external junction box is required
AC output	Grid-connected operation	Rated output	10 kW		
		No. of phases/ wires	Three phase, three wire		S phase ground
		Rated voltage	202 V AC		
		Rated frequency	50 Hz or 60 Hz		
		Rated output current	28.6 A AC		
		AC output current distortion rate	Total: 5% or less 3% or less for each harmonics		Rated output current ratio
		Output power factor	0.95 or higher		At rated output
	Isolated operation	Rated output	–	10 kVA	Load power factor 1.0
		No. of phases/ wires	–	Three phase, three wire	V phase ground: Grounded with power conditioner
		Rated voltage	–	202 V AC	
		Voltage precision	–	Rated voltage within ± 5%	
		Rated frequency	–	50 Hz or 60 Hz	
		Frequency precision	–	Rated frequency within ± 0.1 Hz	
		AC output voltage distortion rate	–	Linear load: Max. 5%	
		Overload capacity	–	100% continuous	
Efficiency			94.5% (Excluding junction box circuit)		Rated load factor based on JIS C 8961
Utility protection function			Over-voltage (OV), under-voltage (UV), over-frequency (OF), under-frequency (UF)		Over-voltage ground relay (OVGR) is installed externally.
Islanding operation detection		Passive method	Voltage phase jump method		
		Active method	Reactive power fluctuation method		
Operation environment		Ambient temperature	-25 to + 60˚C		When ambient temperatures are above +40˚C , the output power is limited
		Relative humidity	90% or less		Non-condensing
		Altitude	2,000 m or less		
Coating color			Munsell 5Y 7/1 (Semi-glossy)		
Transducer function			Yes		For pyranometer For temp. transmitter
Mass			60 kg	62 kg	

*1: "Addition of Alternative Energy Equipment Including Photovoltaic Power Equipment for Disaster Prevention Functionality" February 2012, issued by the Ministry of Education, Culture, Sports, Science and Technology, Minister's Secretariat Department of Facilities Planning and Administration.

*2: As of September 2012. For power conditioners for PV system with the same capacity for use within Japan. Results from Sanyo Denki inspection.

*3: Rated load efficiency based on "JIS C 8961 Measuring procedure of power conditioner efficiency for PV systems". Excluding junction box circuit.

*4: Classification defined in "JIS C 0920 Degrees of protection provided by enclosures (IP Code)".

*5: In a location that does not received direct sunlight. If the ambient temperature exceeds 40˚C, rising temperature is suppressed through limited output.

*6: JET = Japan Electrical Safety & Environment Technology Laboratories

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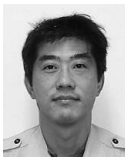

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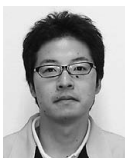

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